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THE USE OF AN AUTOMATED WEIGHING AND RECORDING SYSTEM FOR THE STUDY OF THE BIOLOGY OF ADÉLIE PENGUINS (*PYGOSCELIS ADELIAE*)

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Abstract: A system that automatically weighs, identifies and determines the direction of penguins moving between their breeding colony and the sea is described. Data obtained from it for a complete colony (589 nests from which 412 chicks were fledged) and related to the foraging ecology of the Adélie penguin *Pygoscelis adeliae* are presented for the period hatching to fledging. These were obtained at Bechervaise Island (total Adélie penguin population 1816 nests) near Mawson Station, Antarctica during the 1991/92 breeding season. The system logged more than 80000 penguin crossings over a period of three months. Results show that from hatching (20 December–10 January) onward males and females deliver a similar mass of food to the chick per visit despite males being approximately 480 g (11.5%) heavier when empty. A mass of 45 kg was delivered to the colony for each chick raised to fledging. The average fledging weight was 3.1 kg. The value of the system for large scale data collection in long term monitoring and biological studies is discussed.

1. Introduction

Studies on nesting seabirds which require repeated capture of individuals for identification and measurement cause interference which may result *inter alia* in both short and long term changes in behaviour and decreased breeding success. Such interference places severe limitations on long term investigations particularly those involving monitoring where the methods of study may critically alter the results. Further, such studies are limited by the number of birds that can be handled and frequently require a large manpower resource to ensure an adequate sample size and continuous surveillance.

This paper describes an entirely new system which automatically weighs, identifies and determines the direction of penguins as they move at walking pace across a weighing platform placed between their breeding colony and the sea. It thus reduces to a minimum the need to handle birds where weight and identity are required on a regular basis. A preliminary analysis of data obtained using the system during the 1991/92 breeding season at Bechervaise Island, Antarctica is presented to demonstrate its power in gathering data on foraging at the level of a whole penguin colony. Manually gathered data on breeding chronology and variations in population composition of the Bechervaise Island Adélie penguin rookery are provided as a basis for interpretation.

The impetus for the development of an automated means of determining the movements and weights of individual penguins was provided by the requirement of the

Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) for a long term ecosystem monitoring program involving Adélie penguins as one of the key species to be studied. Variables relating to the breeding success of the Adélie penguin which are required by this program and can be derived from automatically collected data on individually tagged birds include weight on first arrival, length of incubation shifts, duration of foraging trips, fledging weights and breeding chronology. It is possible to determine at the level of the whole colony or the individual bird the total mass of food brought in as a function of time as well as the rate at which birds enter and leave their nesting sites.

2. Methods

2.1. *Study site*

Investigations were undertaken between 12 November 1991 and 5 March 1992 at the Adélie penguin colonies (67°35'14.54" S, 62°48'45.65" E) on Bechervaise Island approximately 2 km NW of the Australian Antarctic Station of Mawson. The colonies (Fig. 1) which contained a total of 1816 nests in December 1991 are labelled A–R.

The colonies K, L, M, N, and Q (Fig. 1) which contained 589 nests on 9 December were selected for the trial of the Automated Monitoring System. These colonies could be semi-isolated through the addition of short distances of 300 mm high wire netting fences to the natural rock boundaries. The remaining nests were set aside as minimum interference controls. Birds moving into the colonies followed a well defined path through a natural gateway. The weighing platform and associated detection systems (see below) were placed at this gateway (Fig. 2).

Two hundred nests within colonies L and Q were marked with numbered plastic tags anchored to the basement rock. The occupants of these nests were recorded during the 1990/91 and 1991/92 study periods as required by the CCAMLR Ecosystem Monitoring Program (CCAMLR, 1991).

2.2. *Identification of birds*

Birds within colonies L and Q were identified by appropriate dye marks and once away from the area were banded and/or tagged with an implanted electronic identification tag (containing a unique encoded 16 digit number) and their sex determined by cloacal examination as described by Sladen (1978). Bands were placed on the left flipper for males and right for females. Electronic identification tags (TIRIS, Texas Instruments) which are passive transponders and can theoretically last the life time of the bird were used for the first time commencing 20 November. These tags are glass coated, 24 or 32 mm long, 3 mm in diameter and are supplied in antiseptic Betadine in cartridges ready for injection. They were implanted by holding the bird on its stomach with its head bent downwards and then injecting the tag into the neck under a pinched fold of skin with the needle pointing toward the head such that the tag was vertical when the bird was standing. Initially several tags were lost by working their way out from the wound. This happened within a few hours of implanting before the wound healed and occurred in thin dehydrated birds that had been incubating eggs for

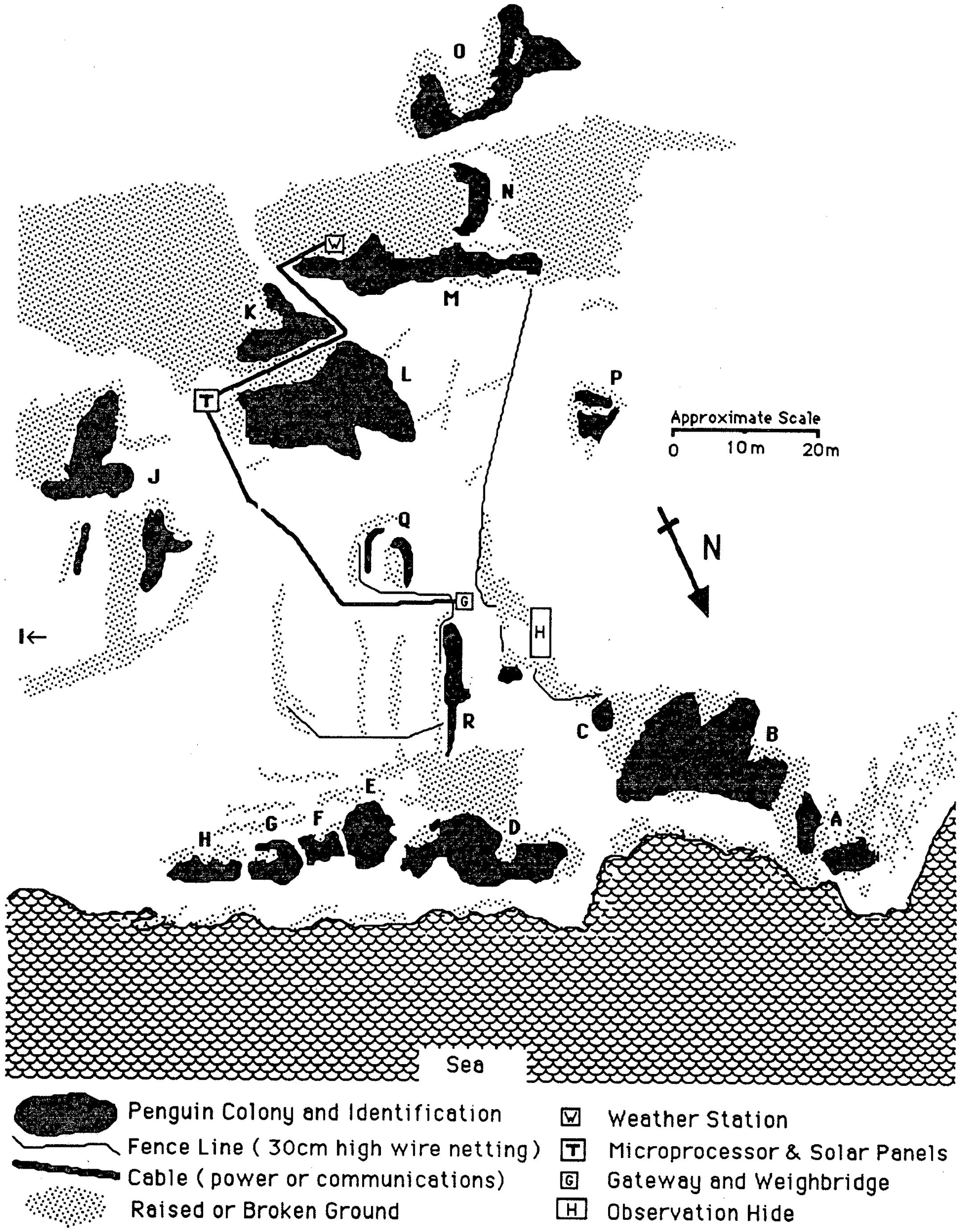


Fig. 1. Plan of the study site at Bechervaise Island showing the location of the weighbridge. The penguins associated with the study colonies K, L, M, N, and Q must cross the weighbridge as they pass through the natural rock gateway. The guiding fences and the topographic features which assist in this process are shown also.

long periods. Many of these birds were subsequently recaptured and successfully retagged on return from feeding. There was no evidence from recapture of tagged birds that the tags migrated away from the injection site or caused any physical dam-

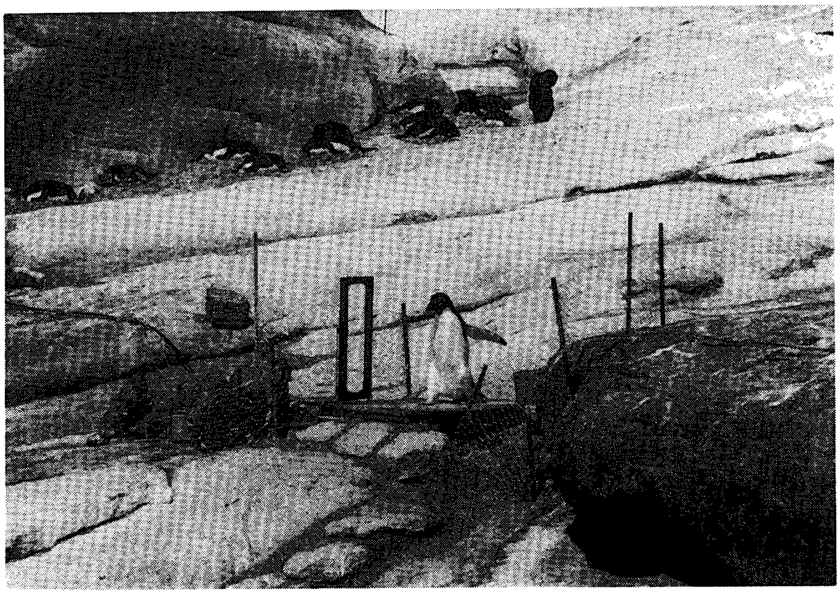


Fig. 2. View from the sea to the weighbridge. Part of study colony Q is in the background.

age.

By 27 December 54 males and 70 females were electronically tagged (Appendix 1) and from 26 January onwards the number of permanently identified breeders totalled 96 males and 100 females. Forty chicks were tagged during the period 5–11 February. Four of these died of unrelated causes 2–3 weeks later. Post mortem investigations showed no abnormalities around the implanted tag.

2.3. Automated Monitoring System

The Automated Monitoring System consists of a weighbridge, an electronic tag reader, a direction detector, and a system controller and data logging device. It was installed and tested during the austral summer 1990/91 and became operational on 30 November 1991. The penguins are weighed and identified as they walk across the platform; no restraint is required.

The weighbridge is a low profile stainless steel platform (600 × 600 × 50 mm) without raised sides. The average weight on the platform is determined using load cells and sent to the system controller 8 times per second. The pattern of these weights is recorded and an algorithm applied to determine the final weight. A weight error is recorded if set conditions are not met including occasions when the bird crosses too quickly for a valid series of weights to be obtained. The final weight is recorded to the nearest gram and the scales have an accuracy of better than ±5% of the static load. The weight of a bird crossing at walking pace is obtained in under 2 s.

The weighbridge was calibrated by the application of static loads of known mass and then in the field by comparing the recorded weights of individual birds with the values obtained using a spring balance for the same birds captured immediately after they crossed the platform. The spring balance with a clockface scale (Salter) weighed to 10 kg with 50 g graduations and was read to the nearest 25 g. The weights recorded by the weighbridge were on average 29±153 g (n=60) more than those read from the spring balance for the same birds. This difference was not statistically significant (t=−1.45, df=59, P>0.1). However, a systematic error was identified where inbound birds weighed 83±146 g (range −168 to +427 g) more and outbound birds 26±141 g (range −443 to +371 g) less than that determined by the spring balance. This difference is statistically significant (t=2.95, df=58, P<0.01); the weights of inbound and outbound birds were corrected by adding −83 g and +26 g to inbound and outbound values respectively.

The automatic scales weigh, on a colony basis, adult birds to an accuracy of ±5% although the weights of individual birds may on extreme occasions be in error by 10–15%. Individual errors relate to the speed at which the weighbridge records data and to the empirically based algorithm used to calculate the final weight. The systematic error is due to the manner in which birds crossed the weighing platform. Birds when inbound tended to make a considered jump onto the platform whereas outbound birds simply walked across. This produced differing patterns of weight change which were interpreted differently by the software in use at the time.

The direction of travel of the penguin across the weighbridge is sensed by a pair of infra-red beams according to the order in which the beams are cut whilst the bird is on the weighing platform. A directional error is recorded if the beams are cut in the wrong sequence *e.g.* when two birds are on the platform or a bird does not complete the crossing. Direction is still recorded in the event of a weight error.

The tag reader is incorporated into the Automated Monitoring System and the antenna placed next to the weighbridge (Fig. 2). It can detect an implanted tag through the body of a penguin at a range of approximately 1 m. Individual tags, if present, are read as the bird crosses the weighbridge. A hand held tag reader was used to identify birds at their nests.

A microprocessor system controls the various functions and records inputs from the component parts. Each crossing of the weighbridge generates a data set comprising a colony identification character, date/time, direction of travel, penguin weight and tag number and error flags. There is sufficient memory for storing data resulting from 16000 penguin crossings. The system is powered by solar cells and can process data then, if required, download it *via* a VHF radio modem (linked to Mawson station) and transfer it automatically *via* satellite to Hobart or elsewhere.

All "valid" weight data, where both weight *and* direction were recorded at each crossing, obtained by the Automated Monitoring System were corrected for the systematic errors associated with inbound and outbound weights. All data were then analysed in blocks of 5 days. The starting date of each 5 day period was chosen to coincide with the standard reporting dates prescribed by CCAMLR (CCAMLR, 1991). Data for individually tagged birds were included in the main data set but analysed also in 5 day blocks as a subset.

3. Results and Discussion

3.1. Population size and breeding chronology

The colonies at Bechervaise Island contained a total of 1883 breeding pairs in

December 1990/91 and 1816 in December 1991/92. The population of the Island thus has more than doubled in numbers since 1972 and 1988 when counts made in December of 744 and 679 nests respectively were reported (WOEHLER *et al.*, 1989).

The breeding chronology for the Island population for the 1990/91 and 1991/92 seasons is provided in Table 1. The date of the first arrival for the years 1974, 1980, 1981, 1988 and 1990 taken from log books at Mawson Station were all between 20 and 22 October. Thus the season 1991/92 appears to have commenced later (25 October) and remained approximately 6 days late through out the season. The Island population breeds approximately one week later than do colonies on Magnetic Island in Prydz Bay (WHITEHEAD *et al.*, 1990), on Ross Island (AINLEY *et al.*, 1983) and on the Antarctic Peninsula (LISHMAN, 1985).

Breeding success (Table 2) calculated as chicks fledged per nest with eggs was 0.75 in 1990/91 and 0.73 in 1991/92 compared with a range of 0.69–1.33 at Magnetic Island (WHITEHEAD *et al.*, 1990), the nearest colony for which data were reported, and is in general lower than many sites summarised by LISHMAN (1985). There was no difference in breeding success between the study colonies and the remainder of the population on Bechervaise Island.

The mean time from hatching to fledging as measured to the last visit by a parent bird was 56 days as recorded for 61 nests by the Automated Monitoring System. This is slightly longer than the 46–55 days for Ross Island (AINLEY and SCHLATTER, 1972), 50–55 days for King George Island (VOLKMAN and TRIVELPIECE, 1980) and at the lower end of the 54–64 days for Signy Island (LISHMAN, 1985).

The rapid increase of the breeding population on Bechervaise Island over the past 3 years coupled with the later breeding and lower breeding success suggests by comparison with the findings reported by AINLEY *et al.* (1983) that the population may contain a larger percentage of younger and less experienced birds than for instance the colonies

Table 1. Breeding chronology based upon the entire Bechervaise Island population.

	1990/91		1991/92	
	Mean	(Range)	Mean	(Range)
Arrival	30th October	(22 Oct – 9 Nov)	10th November	(25 Oct – 22 Nov)
Laying	19th November	(11 Nov – 29 Nov)	25th November	(17 Nov – 5 Dec)
Hatch	n.d.	(19 Dec – 3 Jan)	n.d.	(20 Dec – 10 Jan)
Fledging	22nd February	(18 Feb – 5 Mar)	25th February	(20 Feb – 4 Mar+)
Creching begins / ends:	n.d. / 29 January		18 January / 3 February	
2/3 chicks in creche:	23rd January		26th January	

Table 2. Nest numbers and breeding success for the study population comprising colonies K, L, M, N and Q compared with the entire population on Bechervaise Island.

	Incubated nests	Chicks	Chicks fledged / nest
	9 Dec 91	15 Feb 92	
Study population	589	412	0.70
Remainder of island	1227	915	0.75
Total population	1816	1327	0.73

reported by WHITEHEAD *et al.* (1990), and LISHMAN (1985). Food availability and sea ice conditions may contribute also to the timing and success of breeding.

Changes in the composition of the whole Adélie penguin population while ashore during the breeding season of 1991/92 on Bechervaise Island are shown diagrammatically in Fig. 3. The diagram is based upon actual counts made in the field related to the breeding chronology reported above. This detail is provided as an aid to the interpretation of the movements of penguins into and out from the study colonies. At the beginning of the season the population ashore consists almost entirely of breeding birds. After hatching, however, the colonies are filled with breeding birds and their chicks as well as non breeding and failed breeding adults, juveniles (1 yr olds) and then moulting birds. The changes in numbers of these different classes reflect the breeding status of birds passing over the weighbridge.

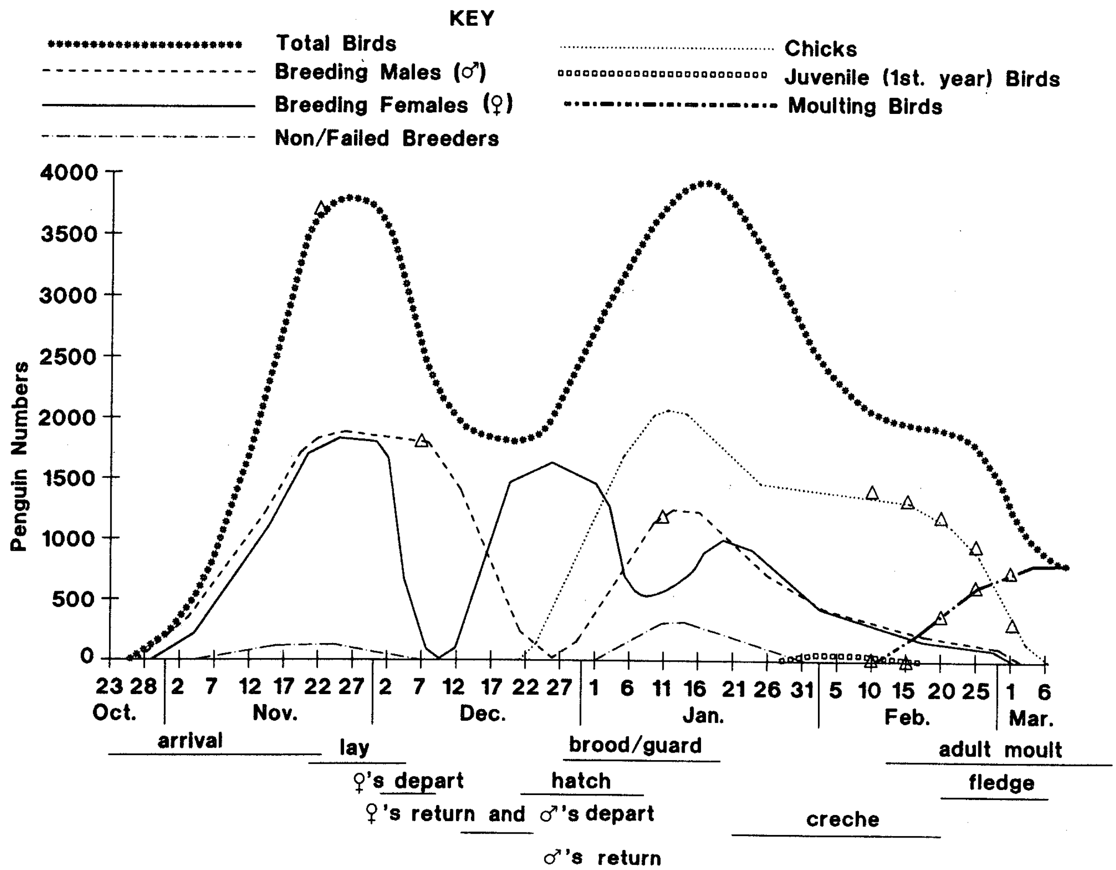


Fig. 3. *Changes in the composition of the whole Adélie penguin population while ashore during the 1991/92 breeding season on Bechervaise Island. This graph is based upon actual counts made in the field (Δ) and related to the breeding chronology reported in Table 2. The changes in composition reflect the status of birds crossing the weighbridge while entering or leaving the study colonies.*

3.2. *Movement of birds into and out from the study colonies*

The total number of crossings of the weighbridge in each direction and crossings where direction was not recorded (directional errors) over each 5 day period are shown in Fig. 4a. Bad weather on 1–2 February caused misalignment of the beams which resulted in 2 days of error recordings. These errors were incorporated into the 5 day mean for the period of 31 January–5 February. The total numbers of crossings where both weight and direction were obtained are givein in Appendix 1. In some instances the numbers of crossings were considerably less (due to the removal of weight errors) than those shown in Fig. 4a; however the pattern was the same.

The data cover a period from 2 December (early egg incubation) to 5 March (late chick fledging). From 2–22 December there were very few crossings since most birds were incubating eggs rather than moving in and out of the colony. The few crossings in the 2–7 December period were made by females departing to sea to feed after laying. The slight rise in the 12–17 December period was due to the incubation shift changeover between departing males and returning females.

The number of birds crossing the weighbridge increased after 27 December as males returned and females departed. As the demand of the chicks for food increased adult birds of both sexes made more frequent foraging journeys and weighbridge crossings increased accordingly reaching a maximum total of 9436 for the 5 day period commencing 31 January. During the period of peak activity (20 January–20 February) the number of crossings occurred at a rate of approximately 1 min^{-1} with a maximum rate of 6 min^{-1}. The reason for the slight dip in the curve at 11–16 January is unknown.

The increase in directional errors after 10 February was due to chicks chasing their parents across the weighbridge. These chases occurred more frequently in an outbound direction since the adults located their chicks after entering the colony and were subsequently chased out. The distance between the adult and the following chick was often so close that a directional error resulted. Eventually the satisfied chicks returned alone at which time their weight and direction were recorded. Once fledging commenced (about 20 February) the number of weighbridge crossings decreased as chicks moved down to the shore.

3.3. Weights of birds moving into and out from the study colonies

The mean weight of all inbound and outbound birds over each 5 day period is given in Appendix 1 and shown graphically in Fig. 4b. An inbound weight of 5.2 kg was obtained on 15 November at nearby Welch Island for 70 birds weighed manually. The birds were at a maximum weight at the beginning of the season (mean of 6.0 kg on 1 November at Welch Island (n=70)); their weight fell progressively as courtship laying and incubation proceeded. Metabolic losses during incubation were estimated as 65 g day^{-1} based upon the arrival weight of 5.2 kg on 15 November and the lowest average outbound weight of 3.9 kg on 2 December. Inbound weights increased from 4.2 kg on 2 December to 5.0 kg on 27 December as first females and then males returned from their post-incubation foraging trips. Outbound weights between 2 December and 22 December remained low (3.9–4.0 kg) since birds were departing after an average of 15 days of incubation. The average weights of both inbound and outbound birds changed little during January but decreased after 10 February due to the large number of unidentified chicks contributing to the statistics.

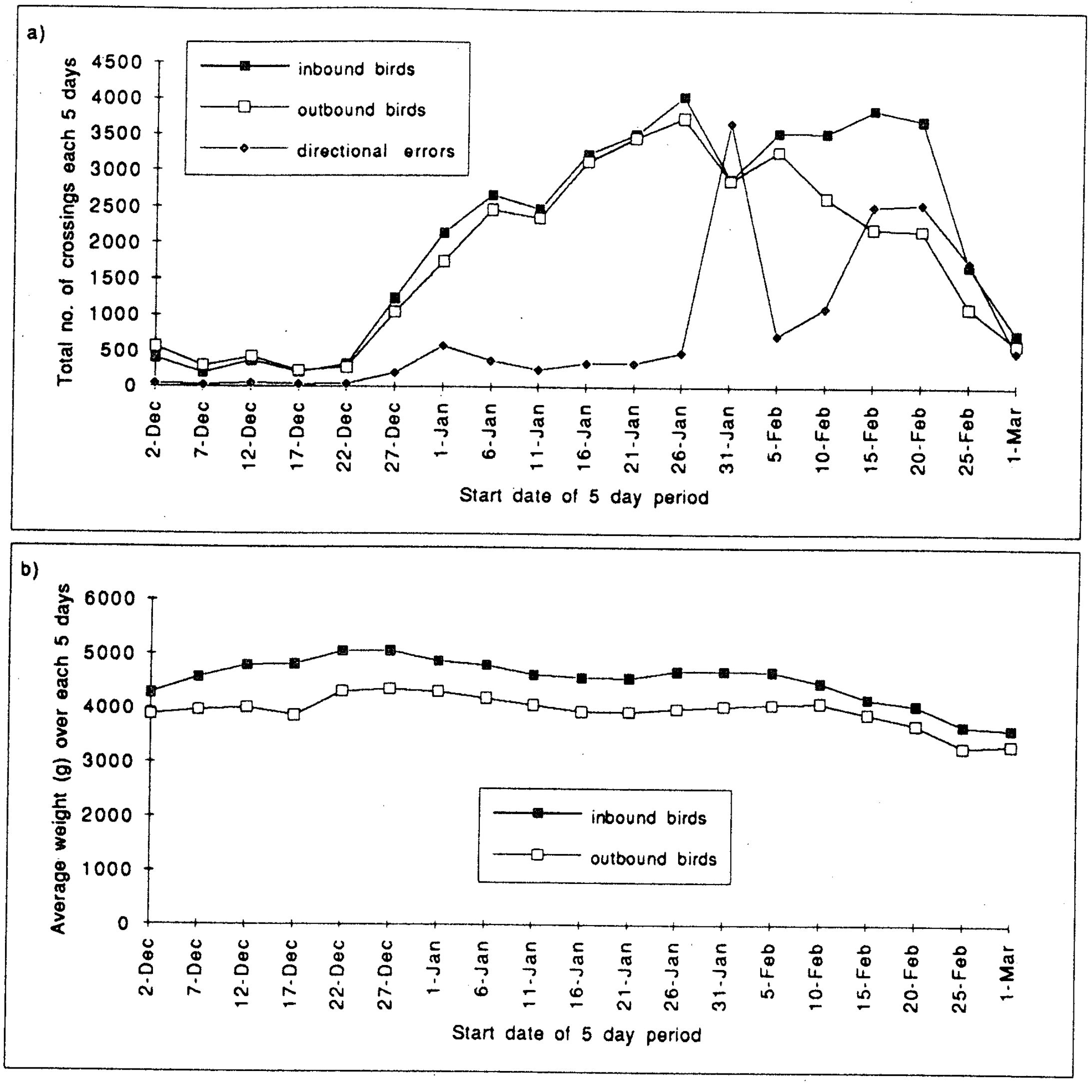
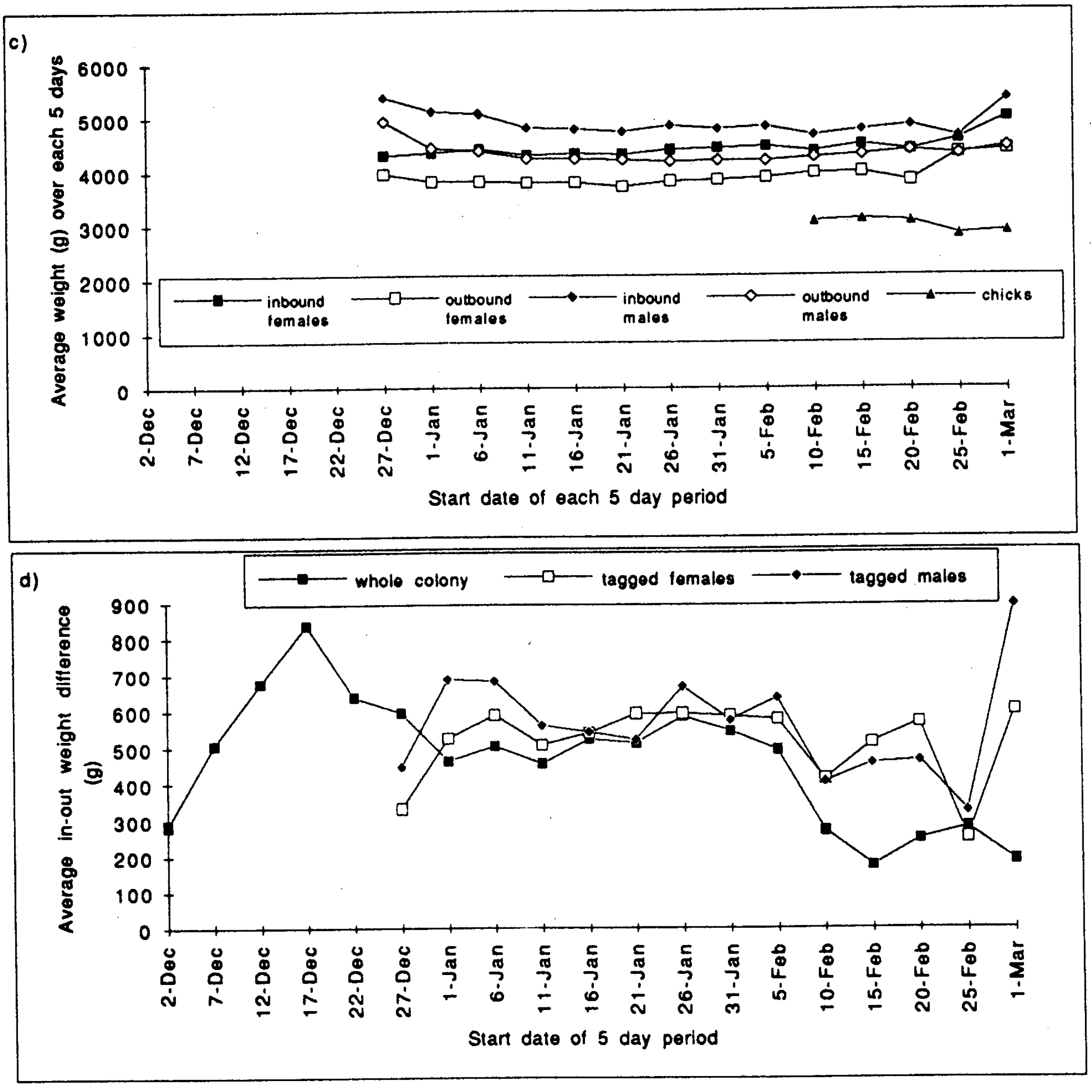


Fig. 4. *a) Total numbers of inbound and outbound crossings of the weighbridge for each 5 day period commencing on the date shown. Directional errors are indicated.*
b) Arrival and departure weights for the study colonies presented as a mean for data collected over each 5 day period.

3.4. *Weights of inbound and outbound tagged females, males and chicks*

The weights of inbound and outbound males and females are shown in Appendix 1 and Fig. 4c. These data were derived from the 96 males and 100 females which had been tagged as known breeding birds. These represented 84 nests with one parent tagged and 56 with both. By 15 February 33% of these nests had failed. Throughout the chick rearing period (27 December on) both sexes maintained a constant body mass although the mean weights of males were always greater than those of females crossing in the same direction.

The difference between inbound and outbound weights for the same tagged birds and the study colonies as a whole is shown in Fig. 4d. This difference remained fairly constant throughout the chick rearing period for both males and females as well as for



c) Arrival and departure weights of males and females tagged as breeding adults. The weights of 36 tagged chicks as determined from repeated crossings of the weighbridge in both directions are shown also.

d) Differences between arrival and departure weights of all birds (breeding, non breeding and chicks), and tagged breeding males and females.

the colony as a whole until chicks became highly mobile. Multiple crossings of the weighbridge by chicks after 10 February resulted in a reduction of the difference between the inbound and outbound weights for the study colonies.

3.5. Fledging weight of chicks

The mean weights over each 5 day period of all crossings made by 36 tagged chicks during feeding chases are shown in Fig. 4c. These values are biased by the smaller birds which tended to cross most frequently. The maximum average weight recorded was 2.9 kg. When the weights of individual chicks were examined separately the mean mass over the whole time period for all 36 birds was 3.1 kg. This is an identical result to that obtained manually when 150 chicks were weighed on the beach between 21 February and 2 March. At fledging chicks weigh approximately 80% and 72% of the mean empty weight of the outbound female and male respectively. This fledging weight is similar to that reported by AINLEY and SCHLATTER (1972) and VOLKMAN and TRIVELPIECE (1980).

3.6. Mass delivered to the study colonies

The difference between the inbound and outbound weights of the adults indicates the approximate mass of food delivered to the study colonies per feeding trip (Fig. 4d). Metabolic losses and elimination products are likely to be very small during the creche period (after 21 January) in comparison with the mass delivered to the chick since the adults at each visit spend a few hours at the most in the colony.

The difference in inbound *versus* outbound weight (Fig. 4d) for both males and females follows that of the whole colony until chick movements affect the latter. The reason for the sudden rise in weight of the inbound and outbound females and inbound males for the period commencing 25 February (Fig. 4c) is unknown but it may be due to failed breeders returning to moult and to parents unable to locate their chicks once fledging is under way.

During the period 27 December 1991 to 5 March 1992 the mass of food delivered by males averaged 550 g (range 446–687 g) per visit compared with a mean of 536 g (range 331–592 g) for females. Using the mean mass differences for each 5 day period as indices in the Mann-Whitney test (SYSTAT 1990) it was shown that there was no significant difference between the weights delivered by males and females ($P>0.1$). The males after January 16 visited 16% more frequently (Appendix 1) but again the difference was not significant ($P>0.1$).

The total mass of food delivered to the study colonies over the period 27 December to 5 March was calculated from the data obtained by the Automated System (Fig. 4a and Appendix 1). The total number of inbound crossings was estimated as half the sum of all crossings (including those where directional errors occurred) for each 5 day period and was multiplied by the mean mass delivered to the colonies for each period. From this calculation a total of 18485 kg was delivered to the study colonies which successfully fledged 412 chicks (from 589 nests) at an average weight of 3.1 kg. This gives an estimate of 45 kg of food entering the study colonies per chick fledged or 14.5 kg for each kg live weight of fledgling.

These gross estimates of food delivered to the colony at Bechervaise Island are very similar to those of krill delivered to Adélie penguins at King George Island (62°10'S, 58°30'W) (TRIVELPIECE *et al.*, 1987).

4. General Discussion

The unique feature of the Automated Monitoring System developed at the Australian Antarctic Division and described above is the weighbridge which is able to determine the weight of a penguin within ±5% whilst it walks across the weighing platform; no restraint is required. This means the system can obtain weight data without direct human intervention and so be operated in remote locations. This weighbridge and the direction sensing device coupled with the use of electronic identification tags (which are implanted and can last the life of the bird) provide a powerful system for use in monitoring and a wide variety of long term biological studies, particularly where it is necessary to minimise disturbance to the birds.

As shown in Fig. 3, the population of a colony changes in composition over the season and interpretation of the data is difficult unless the identity of the bird and its status is determined. Further, for any analysis period multiple trips made by any unidentified bird cannot be distinguished nor can account be taken of time lags between arrival and departure of an individual. The effects of these latter features are smoothed to some extent by analysing the data in 5 day periods.

Interpretation of the data is further complicated by the local movements of birds. Females left the colony during the period of laying to make short but frequent trips to the sea ice to eat snow or ice. "Wandering" (unattached) birds (see AINLEY *et al.*, 1983) also moved in and out of the colony at random passing over the weighbridge. The additional problem of larger chicks chasing their parents over the weighbridge has been described above (see Section 3.2). Despite these complications, collection of data from untagged as well as tagged birds allows year to year analysis of variations in the mass and movements of whole colonies, and complements the data collected from individually identified penguins.

The results obtained from the Adélie penguin colonies at Bechervaise Island over the 1991/92 season by the Automated Monitoring System provided shore based data on the foraging of whole colonies. The fluctuation in numbers and the weight of all inbound and outbound birds were obtained for the entire chick rearing period and from this the mass of food delivered to the colony as a whole was determined. The majority of these results were obtained from birds of unknown age, sex or breeding status. Data on the movements and weights of individual birds are still to be analysed.

Adult penguins were tagged and their sex determined from 22 November onward but by the end of the season only 15% of the breeding birds had been tagged. However, from records of these tagged birds, changes in weight of males and females during the chick rearing period, the fledging rate and weight of chicks and the mass (in terms of food, metabolic products and elimination products) delivered by birds of known status were gathered automatically. The results obtained for these variables are in general agreement with the data gathered elsewhere by manual means (AINLEY *et al.*, 1983; LISHMAN, 1985; TRIVELPIECE *et al.*, 1987).

The monitoring studies being undertaken as part of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) Ecosystem Monitoring Program (CCAMLR, 1991) provide an example of studies which require these kinds of approaches. The required variables of weight and date of first arrival, length of incubation shifts, foraging trip duration and fledging date and weight can all be obtained automatically.

The capacity of the system is limited only by the number of birds which can pass one at a time over the weighbridge. Field experience indicates that birds pass over the weighbridge at a maximum average rate of approximately one bird every 10 s. Thus birds from a colony of 1000 pairs can be metered through a single gateway during the peak traffic period. Larger colonies would require additional gateways each with their own weighbridge and detection systems.

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Appendix 1. *The number of valid crossings (i.e. where both weight and direction were obtained) is shown. Mean weight and standard deviation (SD) for each 5 day period is presented for the population as a whole and for two subsets representing tagged male and female breeding birds. Mean weights are derived from all crossings (n_c) in each 5 day period. The number of individual males and females contributing is indicated by (n_i). The number of birds carrying tags is indicated.*

Date (start of 5 day period)	No. of crossings (n_c)	Mass (mean +/– S.D.) (g)		No. of birds (n_i)	No. of crossings (n_c)	Mass (mean +/– S.D.) (g)		No. of birds (n_i)	No. of tagged birds
	Whole colony (inbound)				Whole colony (outbound)				
2 Dec 91	236	4195	328		389	3912	275		
7 Dec 91	139	4500	493		223	3993	311		
12 Dec 91	310	4717	646		403	4039	315		
17 Dec 91	164	4737	508		213	3899	371		
22 Dec 91	260	4971	512		262	4333	420		
27 Dec 91	994	4974	290		993	4379	250		
1 Jan 92	1830	4799	172		1666	4336	184		
6 Jan 92	2242	4765	169		2287	4220	143		
11 Jan 92	2038	4550	181		2138	4094	149		
16 Jan 92	2799	4501	184		2899	3979	98		
21 Jan 92	3033	4478	154		3203	3965	93		
26 Jan 92	3601	4608	168		3549	4024	97		
31 Jan 92	2636	4622	131		2735	4078	80		
5 Feb 92	3217	4605	427		3054	4113	408		
10 Feb 92	3214	4402	200		2367	4132	213		
15 Feb 92	3380	4103	256		1927	3929	271		
20 Feb 92	3272	3986	290		1930	3738	302		
25 Feb 92	1463	3608	517		1025	3328	583		
1 Mar 92	587	3586	649		494	3366	665		
	Females (inbound)				Females (outbound)				Females
27 Dec 91	19	4304	591	12	37	3973	454	27	70
1 Jan 92	55	4357	499	35	68	3832	396	49	93
6 Jan 92	97	4421	464	50	123	3831	377	60	95
11 Jan 92	68	4306	419	46	88	3800	406	51	96
16 Jan 92	117	4340	438	54	136	3800	366	56	99
21 Jan 92	117	4314	533	58	131	3722	358	61	99
26 Jan 92	163	4409	490	61	170	3817	376	70	100
31 Jan 92	109	4433	384	56	138	3848	342	67	100
5 Feb 92	142	4461	399	52	166	3884	338	66	100
10 Feb 92	138	4378	454	47	123	3966	434	48	100
15 Feb 92	97	4498	572	38	64	3984	616	38	100
20 Feb 92	79	4389	579	35	55	3820	589	27	100
25 Feb 92	34	4589	469	17	24	4339	598	15	100
1 Mar 92	10	4996	1070	9	8	4394	924	6	100
	Males (inbound)				Males (outbound)				Males
27 Dec 91	22	5385	425	13	14	4939	367	8	54
1 Jan 92	49	5125	565	35	45	4438	464	28	75
6 Jan 92	72	5072	596	47	85	4390	471	49	91
11 Jan 92	69	4809	543	47	84	4248	417	56	92
16 Jan 92	120	4786	513	49	147	4244	492	61	96
21 Jan 92	141	4740	469	60	157	4219	420	65	96
26 Jan 92	180	4847	526	60	192	4181	336	62	96
31 Jan 92	124	4785	519	54	161	4212	313	62	96
5 Feb 92	154	4831	502	52	149	4196	359	52	96
10 Feb 92	168	4660	551	47	145	4255	333	51	96
15 Feb 92	137	4766	537	43	91	4310	410	36	96
20 Feb 92	103	4849	610	31	66	4385	528	25	96
25 Feb 92	37	4643	737	13	19	4317	541	13	96
1 Mar 92	20	5338	797	7	15	4445	844	9	96